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Optimized Determination of Deployable Consumable Spares Packages

Dr David Fulk
Dr Douglas Blazer
Mr Rob Kline

Abstract

This presentation will describe the new method the Air Force is using to compute deployment kits for consumable items (the spares required to support a deployed aircraft squadron. The Air Force has used the Aircraft Sustainability Model (ASM) for many years to compute and assess kits for reparable items. Over the past year, ASM was modified to account for the uniqueness of consumable items. This presentation will discuss how ASM computes the range (types of items) and depth (number of items) for consumable kits by minimizing the total number of backorders. We also analyzed different selection methods that filter certain types of items to determine which one performed the best when compared to actual deployment situations. Kits computed by this new technique were used in the CENTCOM area starting in January and some preliminary results will be provided.

Terminology

- MBS = Mobility Bench Stock (also called deployable bench stock)
- CRSP = Consumable Readiness Spares Package
- COLT = Customer-Oriented Leveling Technique
- ASM = Aircraft Sustainability Model
- CENTCOM = US Central Command
- AOR = Area of Responsibility
- MICAP = Mission Capability
- AEF = Aerospace Expeditionary Force
- ERRCD = Expendability/ Recoverability/Repairability/Cost Designator
- BS Flag = Bench Stock Indicator
- MPC = Maintenance Priority Code
- SPC = Stockage Priority Code
- DDR = Daily Demand Rate
- MIC = Mission Impact Code
- LI = Line Item

Overview

- Background
- ASM
- Filtering NSNs
- Follow-on Work

Overview

- **Background**
  - **Deployable Consumables**
  - **CRSPs**
- ASM
- Filtering NSNs
- Follow-on Work

Deployable Consumables

- Currently the US Air Force uses Mobility Bench Stocks (MBS) for deployments
  - User determined, Lack of formal process for defining
  - User maintained
  - No documentation
- Current deployments to US Central Command (CENTCOM) Area of Responsibility (AOR) have more MICAPs than desired
- For all these reasons, the AF is switching to using Consumable Readiness Spares Packages (CRSPs)

Using CRSPs

- AF changed its policy to use CRSPs rather than Mobility Bench Stocks (MBS)
  - Complete visibility of level and usage
  - Forced replenishment (demands recorded)
- Initial CRSP usage
  - Corrects some of the problems, but still lacks a formal process
- A standardized computation was still required
- So AF directed use of Aircraft Sustainability Model (ASM) for CRSP
  - Better support at less cost than MBS
  - Standardized tool
- Modifications were required to ASM for CRSPs and assistance in restricting the range was required to be cost-effective

Overview

- Background
- **ASM**
  - **Standard ASM**
  - **ASM for Consumables**
- Filtering NSNs
- Follow-on Work

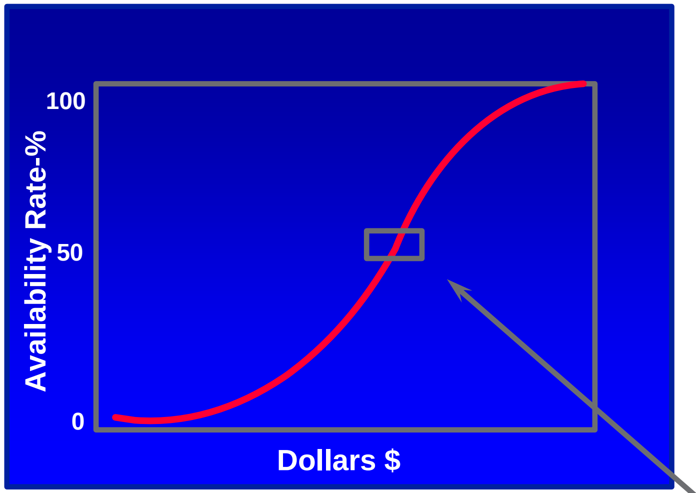
What is the Aircraft Sustainability Model (ASM)

- ASM is standard tool used in the Air Force to compute and assess reparable readiness spares packages (RSPs)
- ASM is a tool that illuminates the implications of a wide range of inventory (spare parts) decisions
  - Initial sparing, replenishments, and deployments
- Typical ASM implementations results:
  - Save 20 to 30% on your spares investment while maintaining system availability, or
  - Comparable improvements in system availability while maintaining spares investment level
- These results achievable for many complex systems
  - Aircraft, electronics, communications networks, ground vehicles, robots, spacecraft ...

A Relevant Measure of System Performance

- Aircraft availability
  - The percentage of “available" (mission capable) aircraft (i.e. not lacking any spare)
  - Example: An 80% availability rate means that 80% of the fleet is mission capable while 20% of the fleet is inoperable for parts
- The spares selection method
  - Choose spares that provide the greatest marginal improvement in aircraft availability per dollar
  - Benefit-to-cost ratio: The improvement in aircraft availability per dollar of inventory investment

Building an Efficient Shopping List



Shopping List

Item (A,B,C...)	Unit cost $	Added end items per $10K	Total cost $	Availability rate %
6th A	1,600	0.388	101,600	66.67
11th B	2,300	0.352	103,900	66.69
2nd C	10,400	0.312	114,300	66.74
12th B	2,300	0.283	116,600	66.76
1st D	13,800	0.154	130,400	66.78
7th A	1,600	0.144	132,000	66.79

Consumable ASM differences

- The model computes the least costly mix of consumables, which minimizes expected backorders, and treats all items as Line Replaceable Units (LRUs) with no cannibalization
- The stockage "stopping rule" uses either a target Issue Effectiveness (IE) rate (instead of aircraft Not Mission Capable-Supply (NMCS)) or a budget constraint.
  - IE is defined as the projected percentage of consumable issues over the planning scenario.
- The model imports a special CRSP text input file derived from the Standard Base Supply System (SBSS) 7SC data, and allows the user to filter and delete inappropriate item records.

Consumable ASM Computation

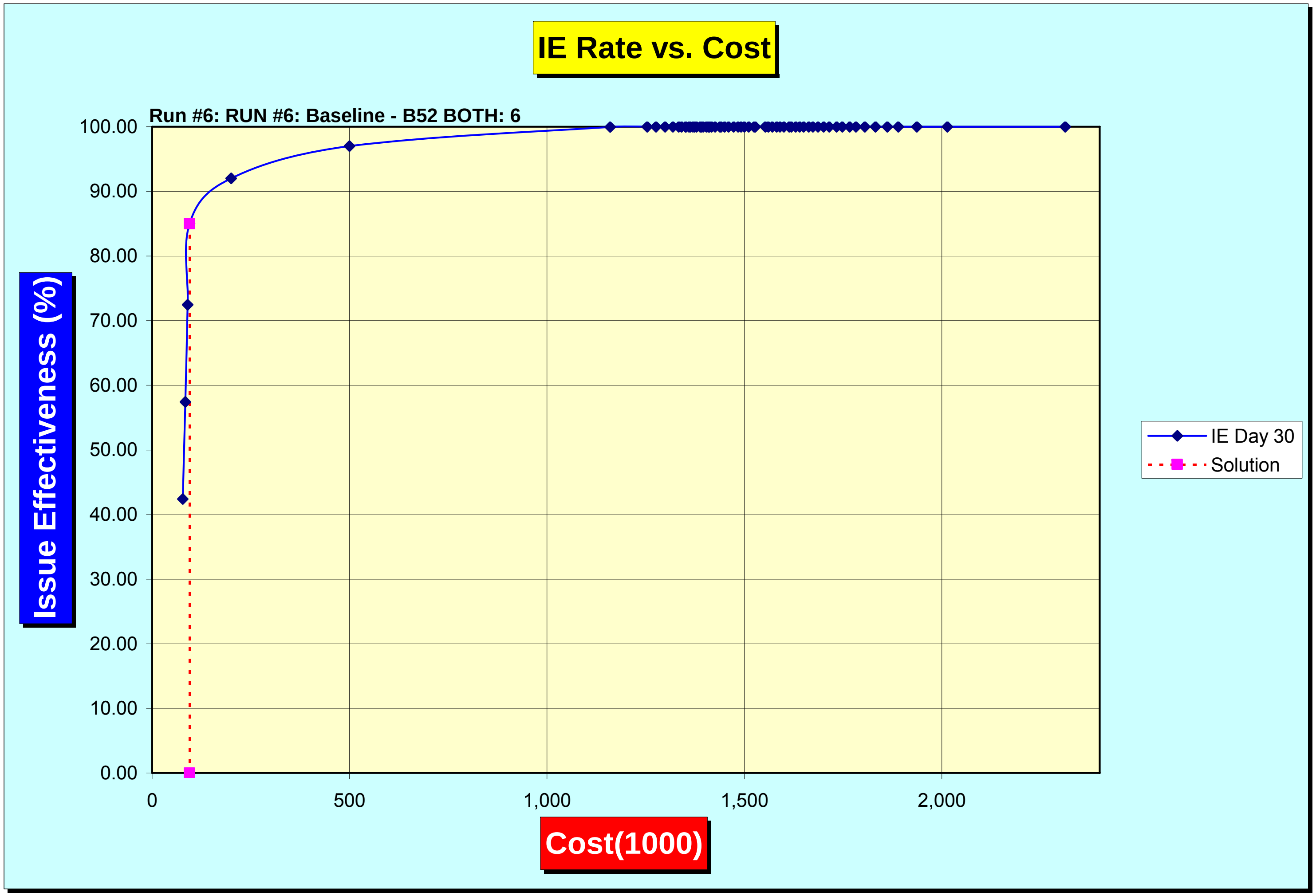
- ASM computes the spares requirements for the CRSP on an item-by-item basis, as well as providing some system-related summary outputs. The model develops a least cost CRSP for the user-specified IE target, where IE is defined as projected inventory *fills* over the wartime scenario

$$IE = 1 - \left(\sum_{i=NSN} EBOs_i \div \sum_{i=NSN} Pipelines_i \right)$$

$$Pipeline_{NSN} = \sum_{Period} FH * TOIMDRW_{NSN}$$

- *where*
  - EBOs = expected backorders given the NSN's authorized stock level
  - Period = the wartime support period
  - FH = wartime flying hours per day
  - TOIMDRW = Historic demands divided by the historic flying hours (entered during import process).

Cost vs Issue Effectiveness



Overview

- Background
- ASM
- **Filtering NSNs**
- Follow-on Work

Determining the Range

- ASM determines the depth
  - That can be 0 or more
  - So it also determines range within the NSNs provided to it
- So what items to input to ASM?
  - Filtering out NSNs with little chance of use, means ASM is less likely to provide a level on a non-value added item
  - Makes the recommended CRSP from ASM more effective and/or efficient
- Evaluated alternative filtering (range restriction) rules
  - Compare performance with old mobility bench stock (MBS)
  - Examine effectiveness using deployed data
  - Consider Field Reparable (ERRCD XF or P) and Consumable (ERRCD XB or N)

Data Examination

- Using transaction histories from the deployed locations, we identified all NSNs that were used
  - Pulled all NSNs from the demand data for the 3 home bases and the SRDs at each
- Matching the results we identified NSNs **USED** or **NOT** USED
  - About 20-25% of the home station we used at the deployed location
- ERRCD, BS Flag, MPC, SPC, Total Pipe, Unit Price and DDR do not appear to be good predictors of future use
- MIC, Line Item (LI) Demands, and the mixture of them appear to be much better

MIC	Not	Used
0	6	3
1	8636	2431
2	3829	1589
3	1071	180
4	1322	157
Blank	29	5

LI DMD	Not	Used
1	4028	242
2	2413	258
3	1555	253
4-6	2870	680
7-10	1799	733
11-20	1530	1052
21+	698	1147

LI DMD and MIC	Not	Used
LI DMD <= MIC	5379	412
LI DMD > MIC	9514	3953

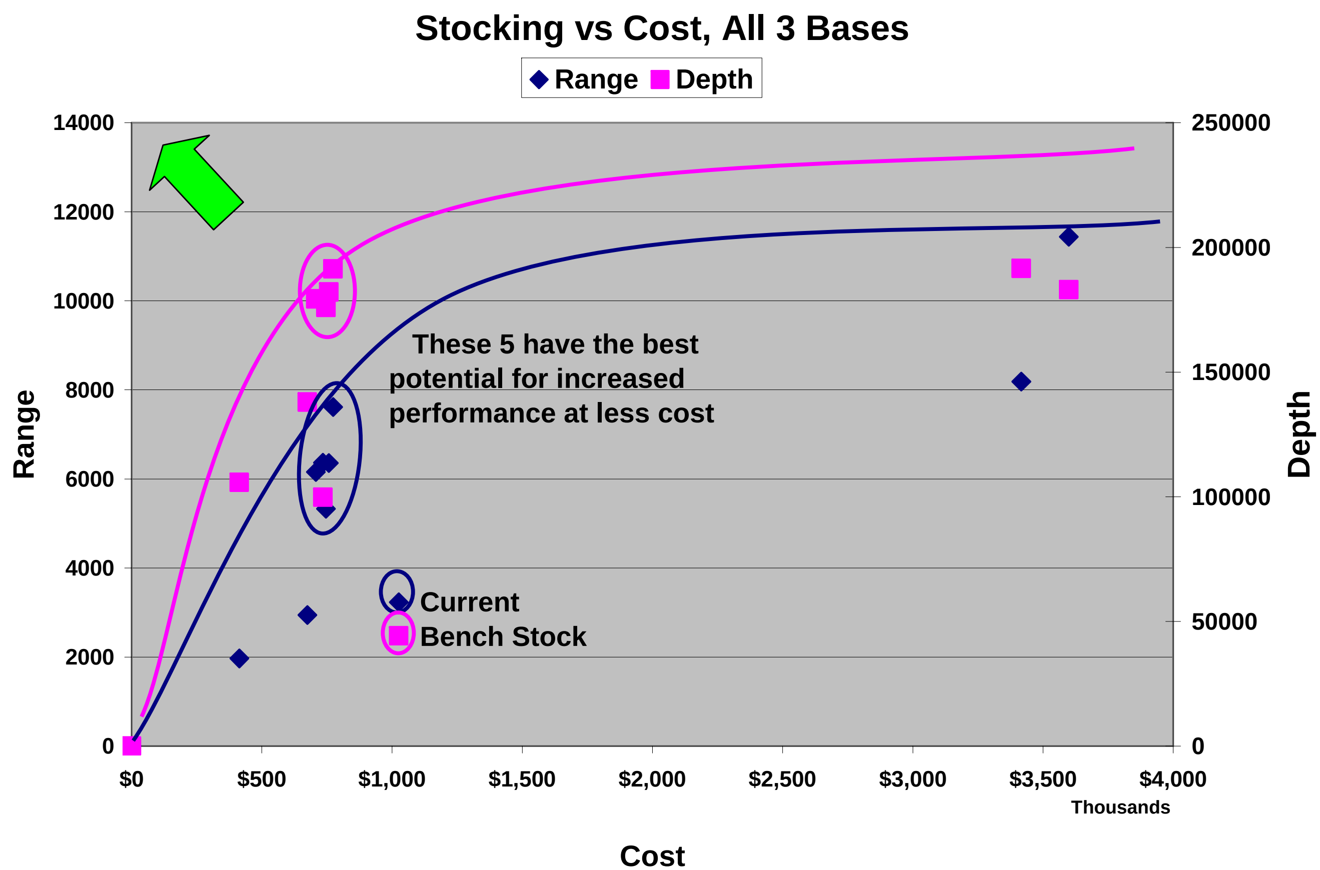
The Suspects and Test Subjects

- Alternatives: Select by SRD and the following alternatives
  - Baseline: Current Mobility Bench Stock (MBS)
  - All: All items (All items for the weapon system)
  - Filter 1: XF and all Bench Stock (not just MBS) items
  - Filter 2: All Bench Stock plus MIC 1-2, SPC 1-3, DDR > 1/60, and some federal stock class (FSC) exclusions
  - Filter 3: User demands > MIC with FSC exclusions
  - XB/XF Sep: All XB and XF separately
  - Final: XB 30 day, XF 15 day separately
- Others were examined, but were significantly poorer and not reported here
- Bases/systems examined in the study:

MDS / SRD	Base	Deployed Base	Deployed Period
B-1B / ABA	Ellsworth	Andersen	Sep 05 – Apr 06
F-15E / ASH	Seymour-Johnson	Al Udeid	Jan 06 – Aug 06
F-16C / AKD	Hill	Balad	Jan 06 – Apr 06

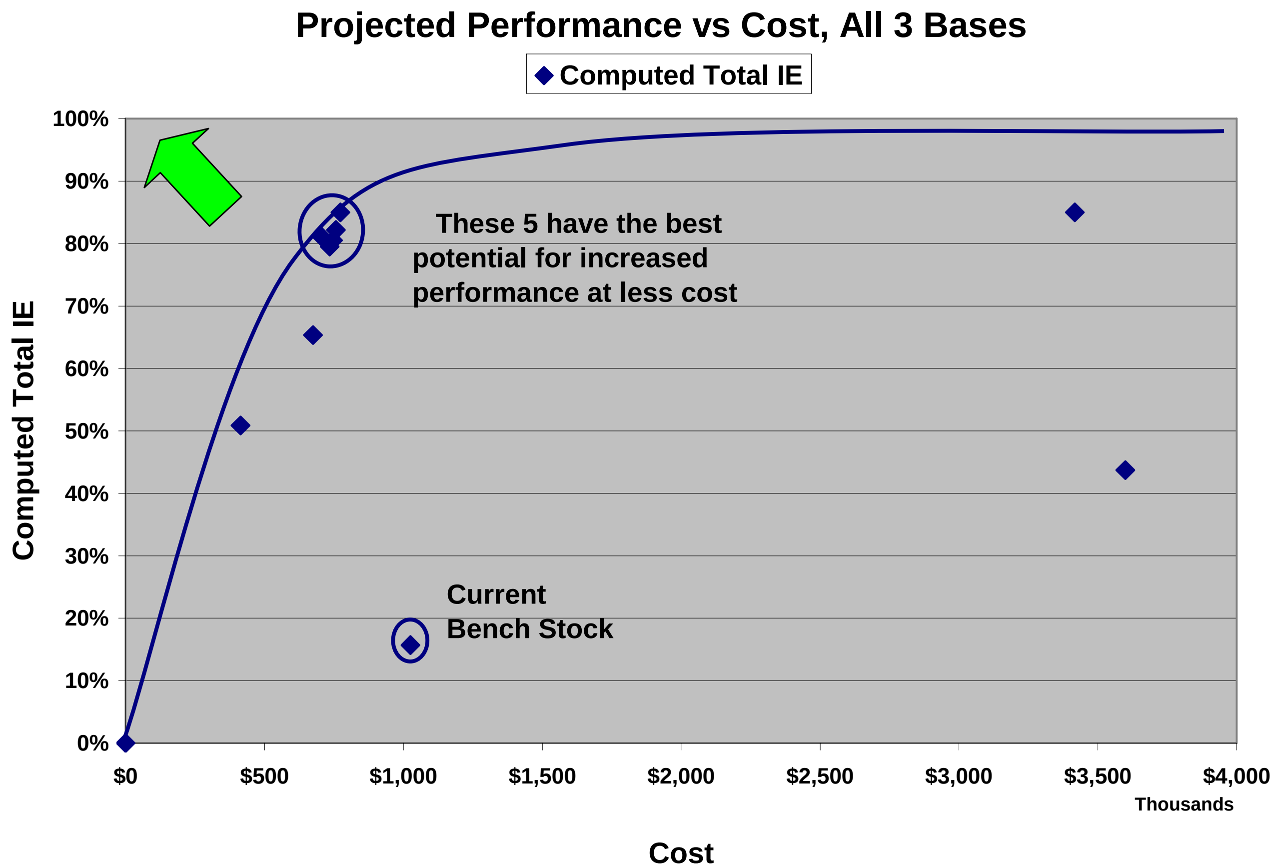
Range and Depth Results

- This chart compares range and depth against the cost
- 5 methods have much larger range (~ 2 times), and depth (~4 times) for less cost (~ 1/3 less)



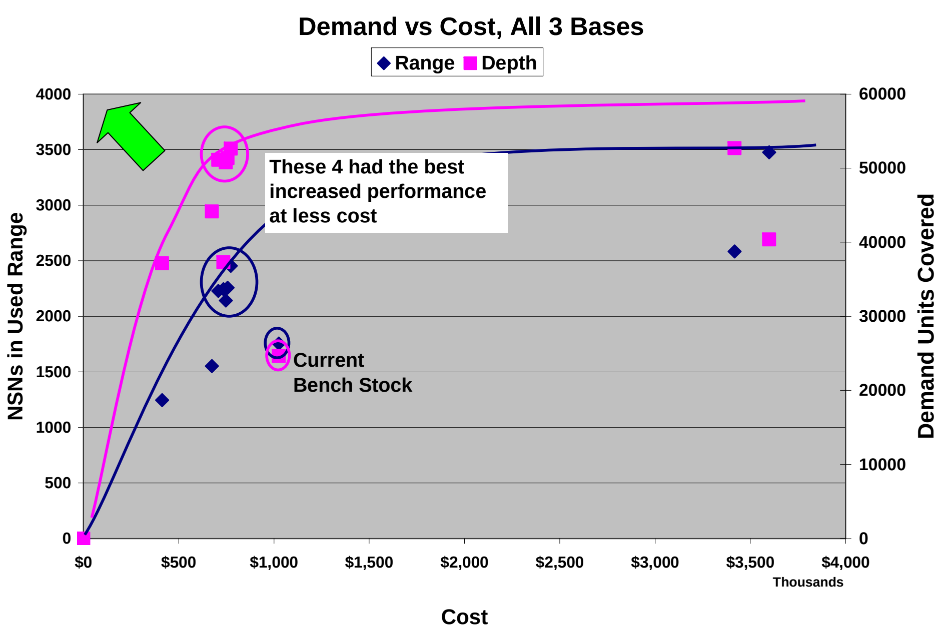
Computed Total IE Results

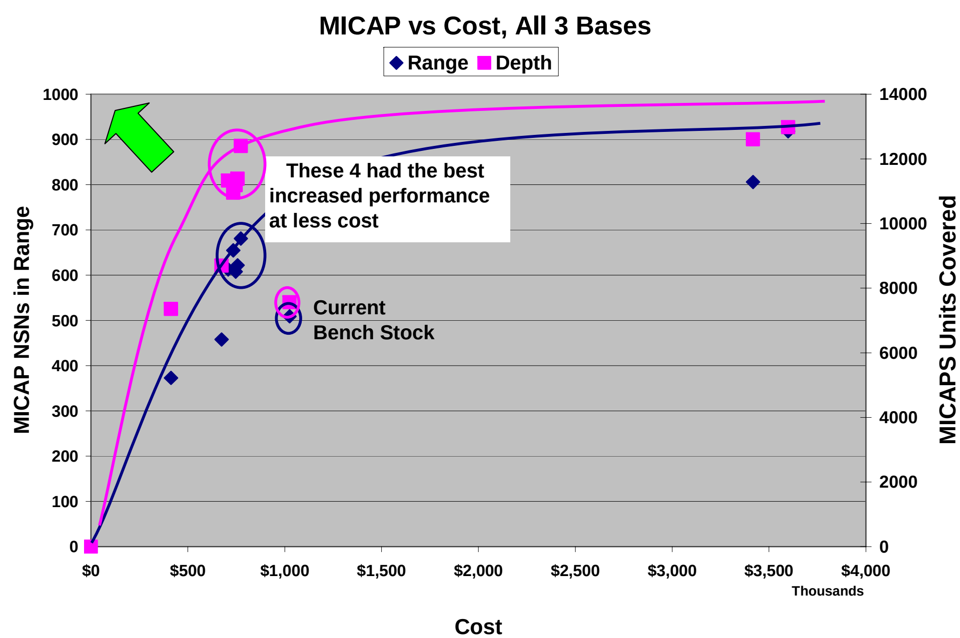
- This chart compares Total IE against the cost
- The same 5 methods have much larger IE (~ 4 times) for less cost (~ 1/3 less)



Usage Results

- These charts compare the cost versus
  - NSNs used and units covered
  - MICAP NSNs in the range and MICAP units covered





Initial Findings

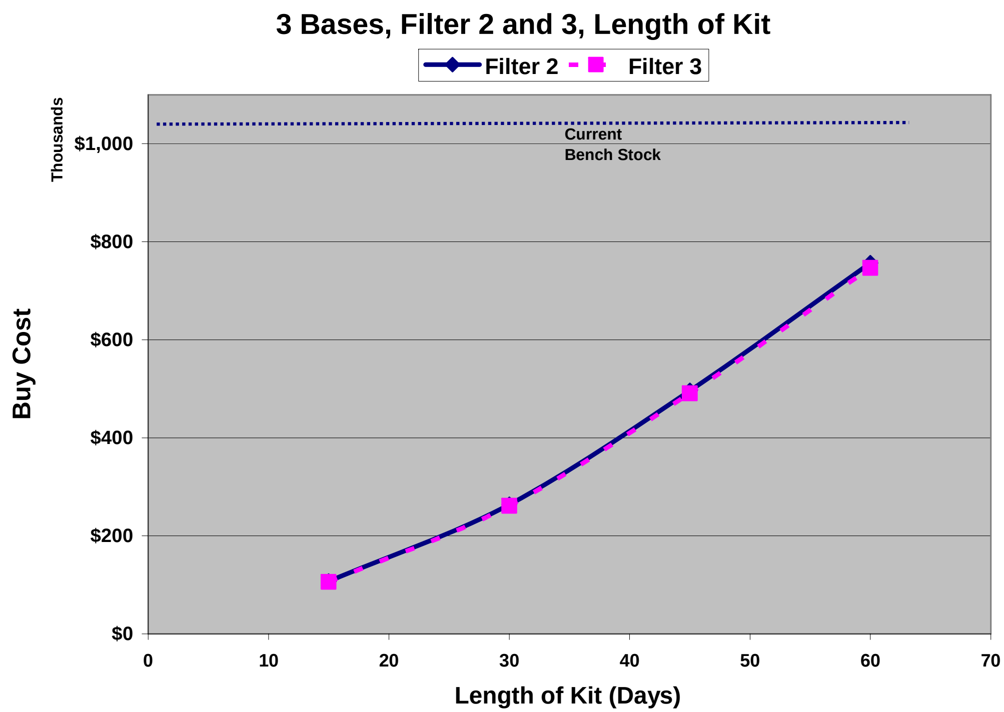
- Several methods improve on current MBS
  - All, Filter 1, Filter 2, Filter 3, and Final all provide better support for less stockage costs
  - The “All” method provides slightly better results than the other 4, but has significantly more unused stock than the others
  - The Sep XB/XF is much more expensive because it is adding a significant number of XF items (see discussion later)
- All methods have some amount of SPC 5 stock
  - All the proposed methods have < 2% of the cost in SPC 5
- The results varied somewhat among the 3 bases

XF CRSP Stockage

- Unfair to compare to MBS which has no XF items
- XF items are used in contingencies
  - About 20-25% of the NSNs are the home station are used at the deployed location regardless of whether they are XB or XF
- XF items don't compete well with XB in ASM
  - Higher cost and lower demand prevent stockage
  - 5% of the NSNs in this study are XF; but less than 0.5% of the NSNs in the range are XF for all the methods studied except XB/XF_Sep
- Reducing the length of time of the kit from 60 days to 15 days cuts the cost about in half
  - It has very little impact to the range, range used, and range used for MICAPs
  - It cuts the depth, units covered, MICAP units covered, and MICAPs avoided

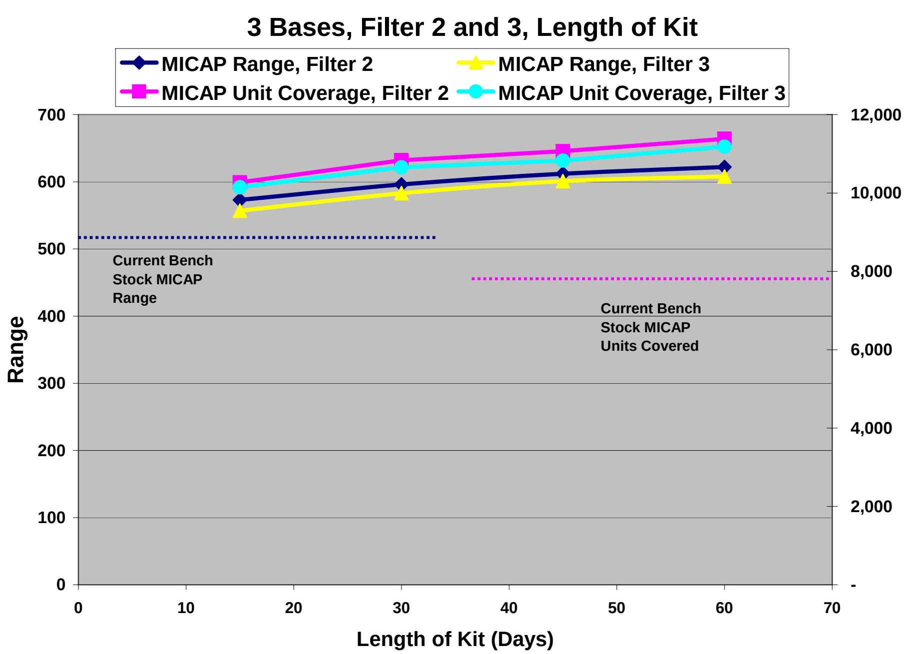
Initial Re-supply Length Target

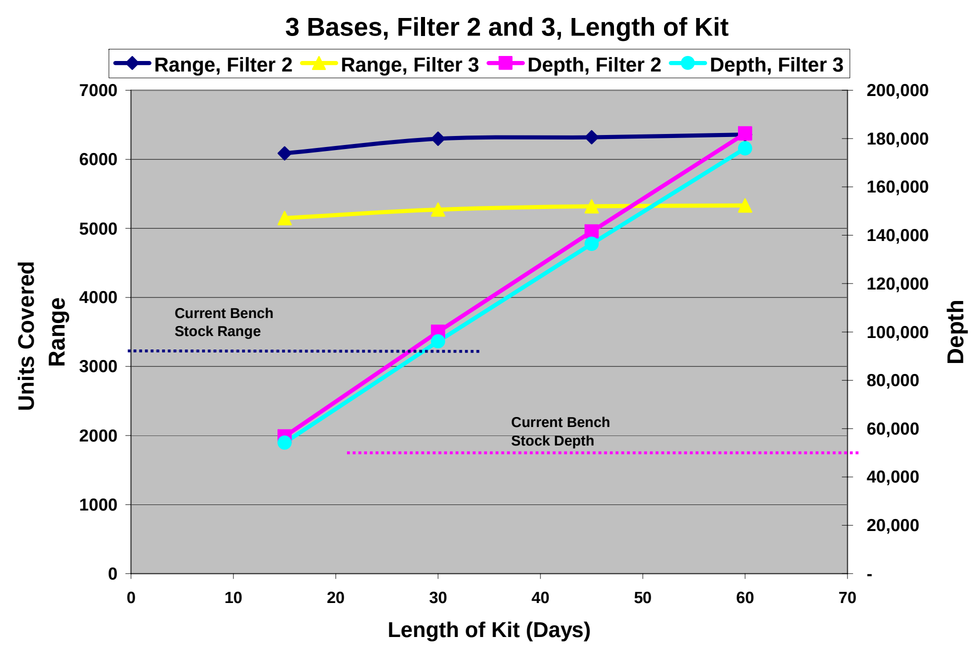
- All the runs to date used a 60 day initial re-supply target in ASM
  – Need to determine sensitivity to length and possibly other values
- Used only Filter 2 and Filter 3 for all 3 Bases for this analysis
- Lengths examined: 15, 30, 45, and 60
- Cost results
  – Steady growth in cost from $106K to $757K



Initial Re-supply Length - continued

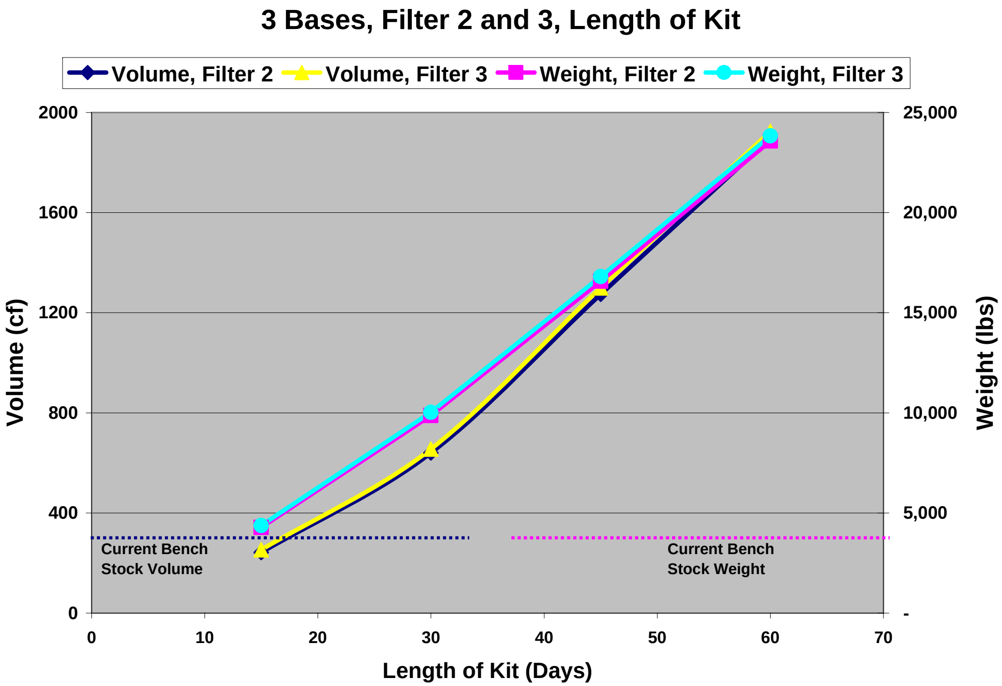
- Range and Depth
  - Very little change in range (from 6087 to 6356 or 5147 to 5332)
  - Large, constant increase in depth (from 54K to 182K)
- MICAP Coverage
  - Constant increase range coverage – no major changes over the days





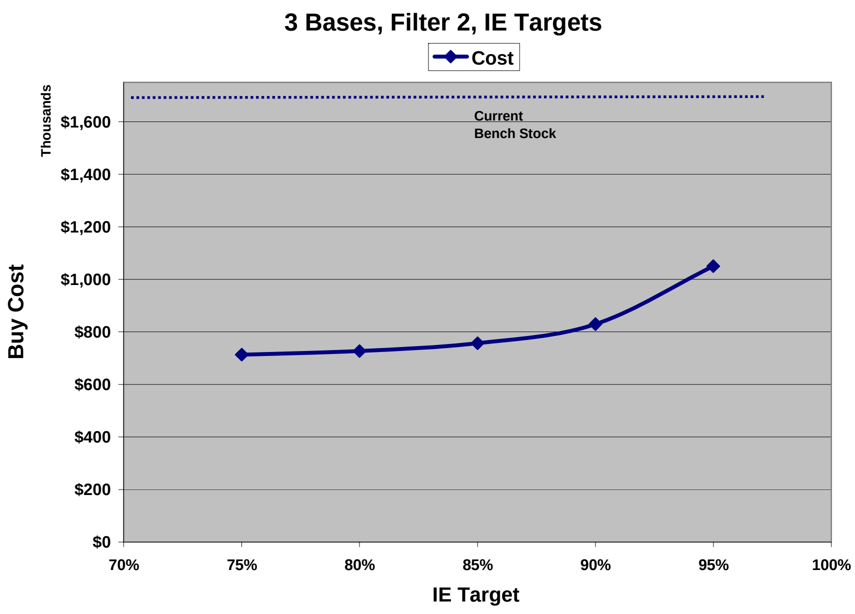
Initial Re-supply Length - continued

- Volume and Weight Results
  - Volume and Weight both decrease significantly as length of the kit decreases
  - 30 day kits are larger than the current bench stock while 15 day kits are slightly smaller
- Summary
  - Reducing from a 60 day kit could save significantly in cost
    - Small impacts to range and actual MICAP coverage
    - Large drop in depth
    - Many more partial units covered versus fully covered
  - Reducing the timeframe to no less than 30 days seems like a reasonable trade off of cost and performance



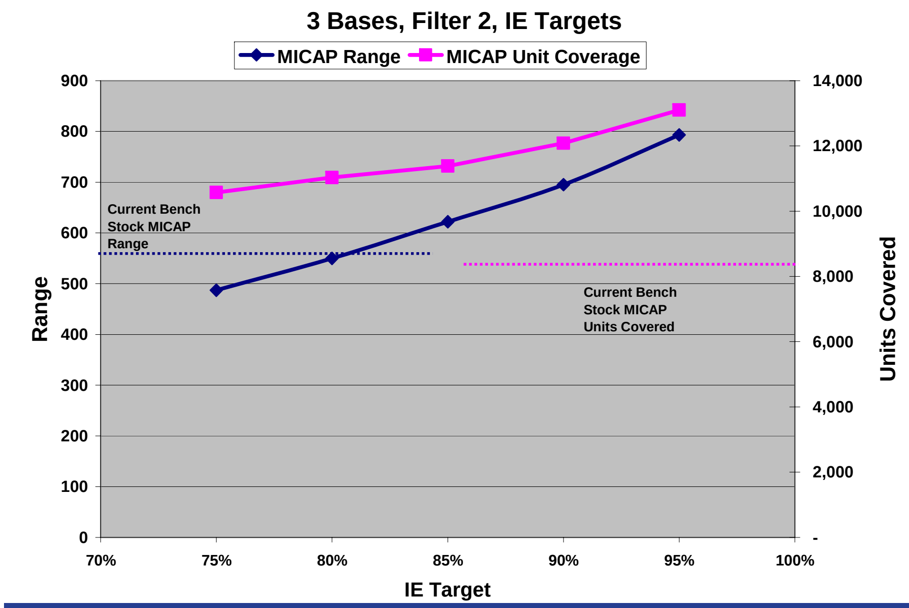
Issue Effectiveness (IE) Target

- All the runs to date used at 85% IE target in ASM
  - Previous work indicated that this was a “sweet spot” on the cost-performance curve
  - Need to determine sensitivity to IE and possibly other values
- Used only Filter 2 for all 3 Bases for this analysis
- Targets examined: 75, 80, 85, 90, and 95% targets
- Cost results
  - Exponential growth in cost for performance after 90%
  - Very little reduction in costs below 85%



IE Target - continued

- Range and Depth
  - Constant increase over the IE targets – no major jumps or slowdowns
- MICAP Coverage
  - Constant increase range coverage
  - Slow increase in MICAP units covered



- A range of 80-90% for IE target is good
  - Cost for performance is good
  - Maintaining the currently used 85% would save 14% over going to 90% IE target; but costs 5% more than going to an 80% IE target
  - 90% IE target uses about 14% more of the NSNs and covers about 7% more units demanded
  - 80% IE target uses about 15% fewer of the NSNs and covers about 8% fewer units demanded

Overall Recommendations

- Adopt “Final” method
  - Use Filter 2: All Bench Stock plus MIC 1-2, SPC 1-3, DDR > 1/60, and some federal stock class (FSC) exclusions
  - Run XB3 and XF3 run separately
  - XB3 run to 30 day target
  - XF3 run to 15 day target
  - Run all to an 85% IE target

Overview

- Background
- ASM
- Filtering NSNs
- **Follow-on Work**

Real World (AEF 5/6) Kits

- Computed 5 CRSPs as first live test of methodology
- Used in AEF 5/6 starting Jan 2007

Base MDS SRD	ERRC	Original			Bench Stock		
		Range	Depth	Cost	Range	Depth	Cost
Ellsworth B-1 ABA	All	1,587	17,799	$157,686.63	771	11,708	$385,353.35
	XB3	1,564	17,752	$46,336.88	771	11,708	$385,353.35
	XF3	23	47	$111,349.75	0	0	$0.00
Pope A-10 AA1	All	1,192	15,378	$243,182.65	897	5,628	$112,437.93
	XB3	1,141	15,277	$24,701.24	897	5,628	$112,437.93
	XF3	51	101	$218,481.41	0	0	$0.00
Langley F-22 A22	All	1,094	32,818	$203,845.15	991	14,421	$570,181.03
	XB3	1,091	32,809	$173,807.15	991	14,421	$570,181.03
	XF3	3	9	$30,038.00	0	0	$0.00

Real World (AEF 5/6) Kits continued

Base MDS SRD	ERRC	Original Range	Original Depth	Original Cost	Bench Stock Range	Bench Stock Depth	Bench Stock Cost
Mountain Home F-15E ASK	All	1,059	21,638	$193,975.28	867	9,336	$235,114.56
	XB3	1,007	21,531	$46,192.50	867	9,336	$235,114.56
	XF3	52	107	$147,782.78	0	0	$0.00
Cannon F-16 AKD, AKG, AKR	All	1,310	49,091	$438,498.62	887	7,254	$137,512.41
	XB3	1,254	48,949	$224,261.01	887	7,254	$137,512.41
	XF3	56	142	$214,237.61	0	0	$0.00
TOTAL	All	6,242	136,724	$1,237,188.33	4,413	48,347	$1,440,599.28
	XB3	6,057	136,318	$515,298.78	4,413	48,347	$1,440,599.28
	XF3	185	406	$721,889.55	0	0	$0.00

- CRSPs provided 41% more range 183% more depth at 86% of the cost of mobile bench stocks
- CRSPs cover XF3 items
- Previous results show they should be more effective – this will be evaluated once sufficient data are available

Ongoing Research

- Measure performance of first set of CRSPs
- Where should the AF (build and) position CRSPs
- What is the employment concept?
- Determine how to assess CRSPs
- Are CRSPs needed after transition to sustainment operations?
- CRSP/COLT offset
- CRSP for Non-Airborne Assets
- Using Fleet-wide Demands

Summary

- AF transition to CRSPs should provide
  - More asset visibility
  - Visibility of levels and usage
  - Forced replenishment
  - A formal process for computations
- Research will allow for
  - More effective and efficient kits
  - Proper placement of kits
- Meet the wartime needs better than the system in the past without breaking the bank

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QUESTIONS?

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BACKUPS

The System Approach to Inventory Management with the ASM

- Experience with the System Approach to Sparing
- ASM Implementation
- ASM Capabilities
- ASM Demonstration
- ASM Methodology

The ASM's Core Capabilities

- Optimal spares requirements for a single aircraft type (reparable and consumable items)
- Multi-echelon (depot with different size bases) and multi-indenture (LRU/SRU) tradeoffs
- Steady state and/or dynamic scenarios
- Flexible with respect to resupply, maintenance (with or without cannibalization), and other parameters
- Common component considerations across different systems
- Multi-year spares and repair budgets
- Evaluation of existing spares mix
- Interface designed for complex spares analysis

Typical Spares Analyses

- **Initial Provisioning** – Estimate what spares requirements (cost of deliveries) for a specific period (months, quarters, years)
  - Aircraft delivery scheduled entered by period
  - Typically steady-state operations though can include a dynamic period
  - Total budget, year by year budgets, budgets by lead-time
- **Replenishment** – Estimate what spares requirements (cost of orders) by period (similar capability to initial provisioning)
  - Example: given existing assets, determines procurements in coming year.
- **Deployment Spares** – Estimate what spares needed if aircraft brought to new location (e.g., IRAQ)
  - Usually dynamic conditions with cannibalization
- **Evaluation** of spares mix by day over a dynamic period (availability and sortie generation).

ASM Users

- US Air Force
  - The standard model that generates wartime spares requirements and assessments Air Force-wide
  - Analyzes key policy issues
  - Supports the JSF and F-22 initial provisioning programs
- Israel Air Force
  - Re-engineered logistics support concepts
  - Initial provisioning
- NASA
  - Estimated spares budgets for Space Station life cycle
  - Evaluated shuttle spare parts performance
  - Performing spares analyses for Crew Exploration Vehicles

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Experience with the System Approach to Sparing

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Mathematical Modeling Group Experience

- US Air Force … over 25 years
  - Developed the standard models that now generate spares requirements and assessments Air Force-wide
    - Peacetime model (The Aircraft Availability Model - AAM)
    - Wartime model (The Aircraft Sustainability Model - ASM)
  - Analyzed key policy issues
    - Developed new policy for retention/disposal decisions with Financial/Inventory simulator (FINISIM)
    - Alternative spares distribution methods
    - Aircraft engine maintenance capacity
    - Demand forecasting
    - Policy impacts on budgets and capability
  - Support to the JSF and F-22 initial provisioning programs

Experience (Continued)
Theme: Systems Approach

- US Defense Logistics Agency Models ... 9 years
  - Developed new ordering policy for sporadic demand items with our financial/inventory simulator (FINISIM).
  - Developed a clothing and textile simulation model for policy analysis
  - Developed retention policy for excess inventory
- Israel Air Force ... 13 years
  - Re-engineered logistics support concepts
  - Initial provisioning
  - Depot repair prioritization
- NASA ... 8 years
  - Estimated spares budgets for Space Station life cycle
  - Evaluated shuttle spare parts performance
  - Performing spares analyses for Crew Exploration Vehicles

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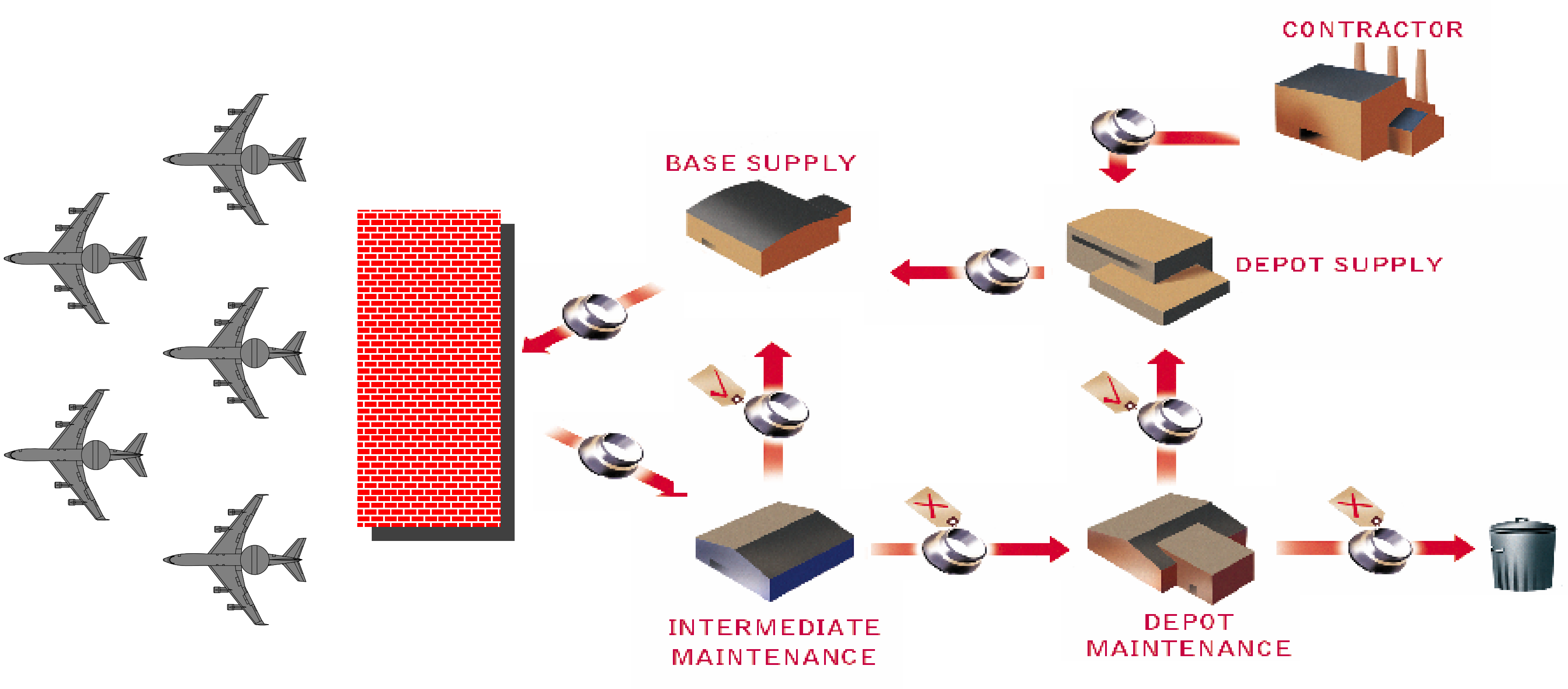
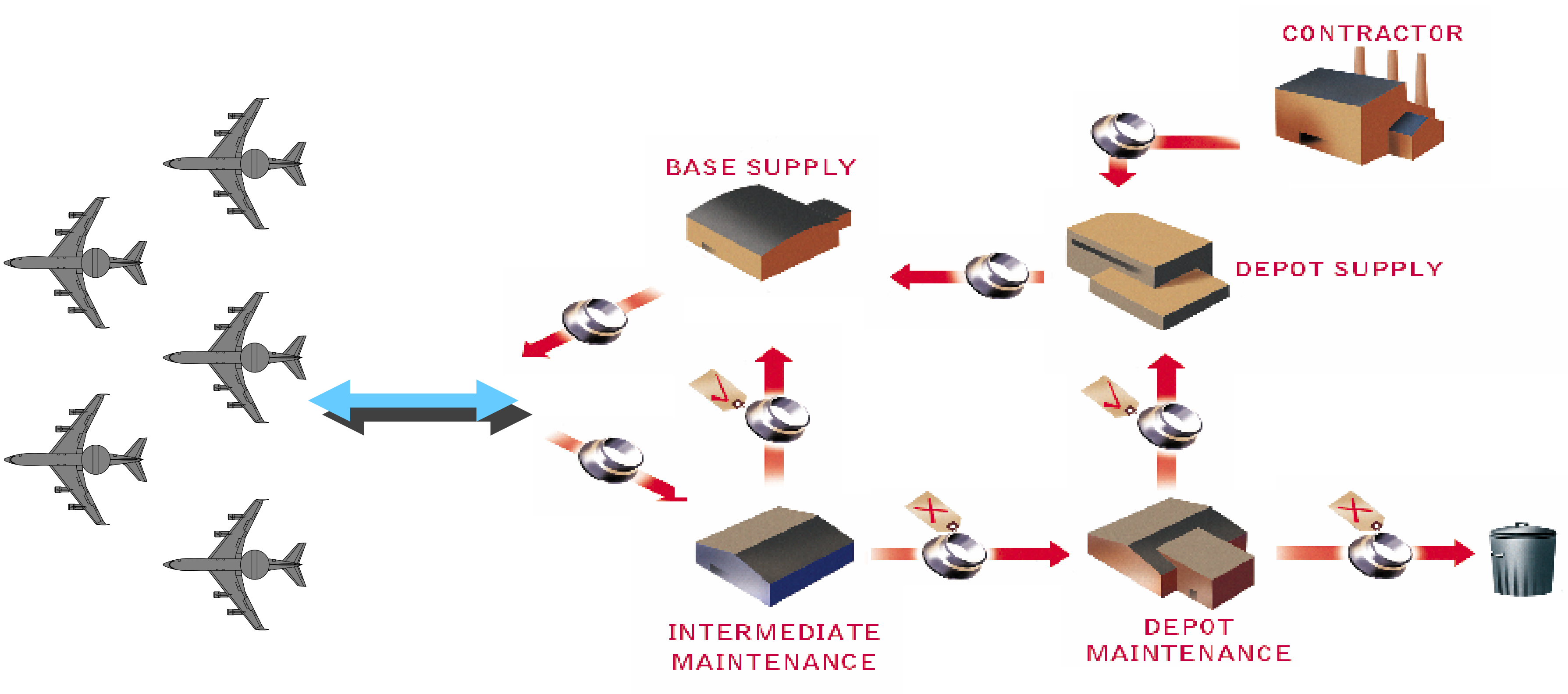
ASM Implementation:

Traditional Supply Support Ignores the Systems Impact of Sparing Decisions



The System Approach Explicitly Links Sparing Decisions to System Impacts

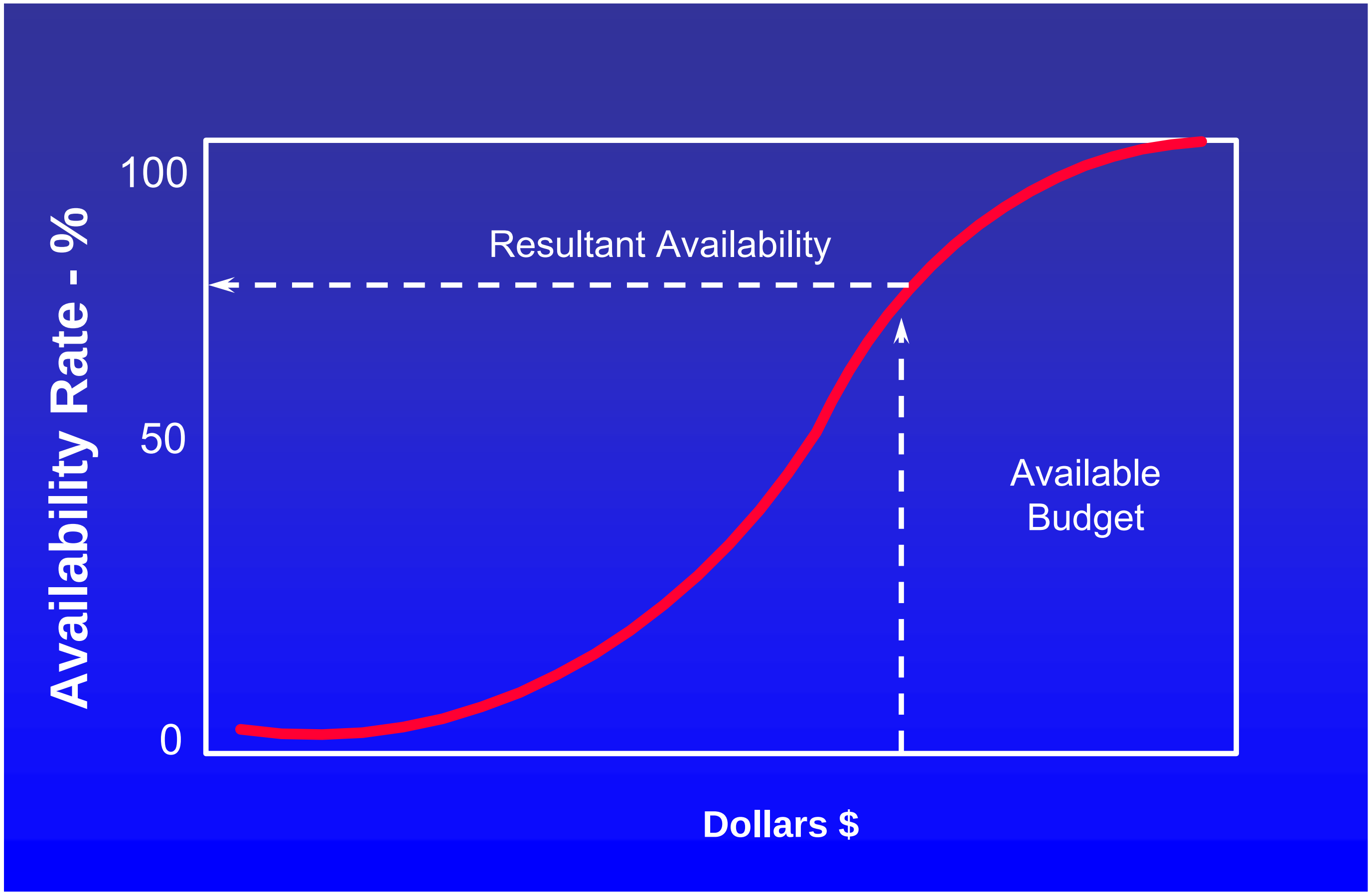


Exemplar Benefits of the System Approach

(Sample results for aviation spares)

	Percent improve-ment of System over Item approach	***Factors compared***
Initial provisioning (reparables)	30%	Cost savings for the same performance
Annual Replenishment (consumables)	18%	Cost savings for same performance
Depot repair (reparables)	40%	Backorder reduction for same cost

The System Approach:
(Marginal Analysis – Or Bang for the Buck)



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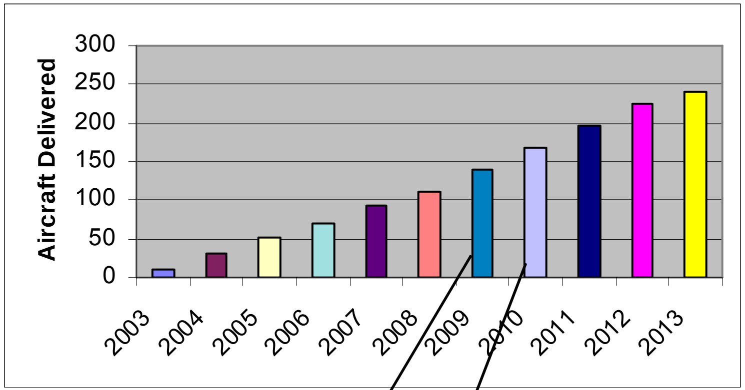
ASM Capabilities

F-22 Budget Computation Over Time

Sequencing RBS
Model Runs by year



Order buys LT before

				Run 1	Run 2	Run 3	Run 4	Run 5	
Year	**CY 03**	**CY 04**	**CY 05**	**CY 06**	**CY 07**	**CY 08**	**CY 09**	**CY 10**	**CY 11**
Deliveries	**Lot 1**	**Lot 2**	**Lot 3**	**Lot 4**	Lot 5	**Lot 6**	**Lot 7**	**Lot 8**	**Lot 9**
…									
Lot 4	LT>=36	24<=LT<36	12<=LT<24	LT<12					
Lot 5		LT>=36	24<=LT<36	12<=LT<24	LT<12				
Lot 6			LT>=36	24<=LT<36	12<=LT<24	LT<12			
Lot 7				LT>=36	24<=LT<36	12<=LT<24	LT<12		
Lot 8					LT>=36	24<=LT<36	12<=LT<24	LT<12	
…									
Budgets		***Sum CY04***	***Sum CY05***	***Sum CY06***	***Sum CY07***	***Sum CY08***	***Sum CY09***	***Sum CY10***	***Sum CY11***

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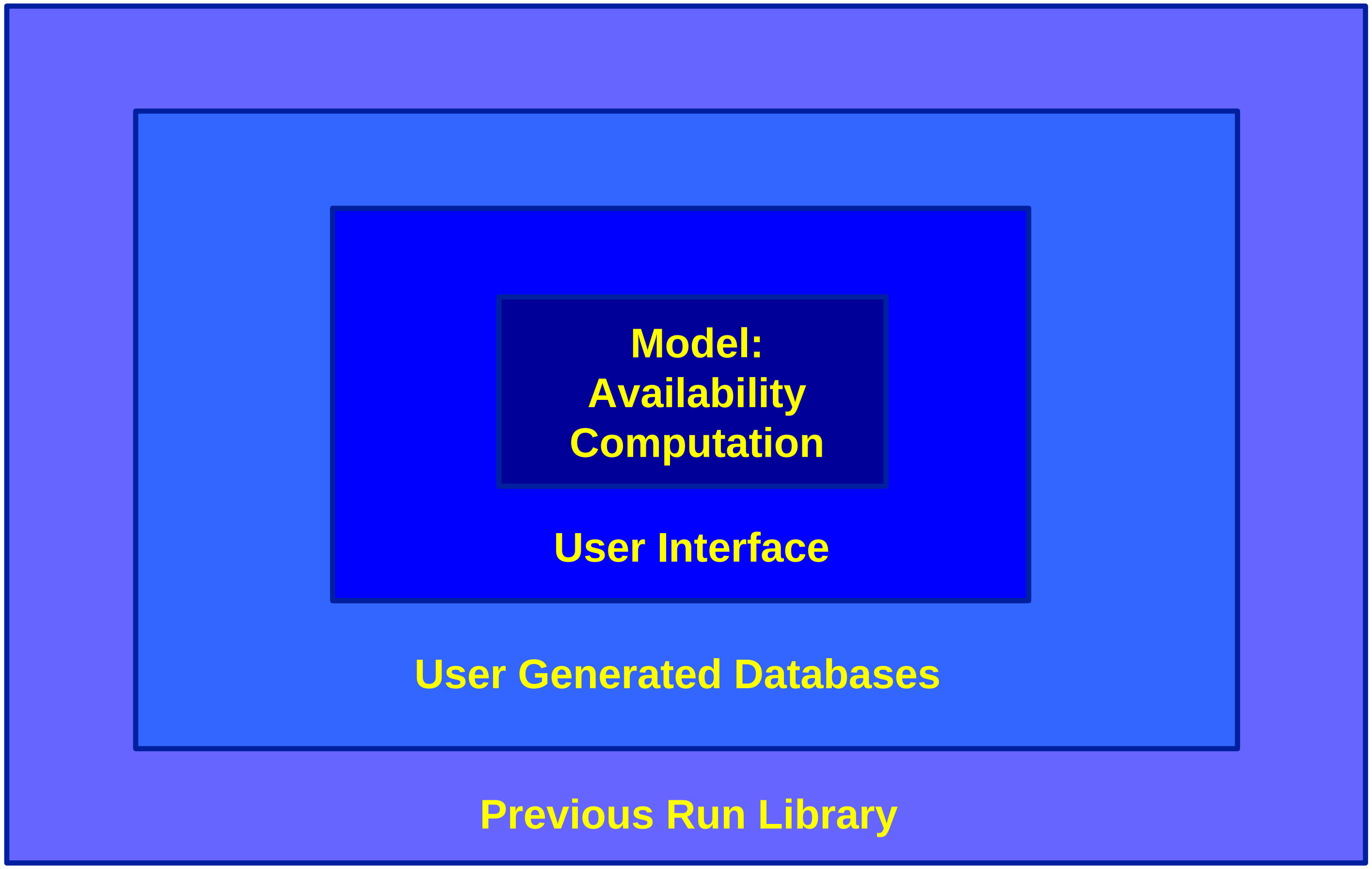
ASM Demonstration

Model Demonstration



Demonstration: The System Approach with the ASM

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ASM Methodology Details

Spares Management

- If failures, repairs, and transportation were deterministic, then there would be $P = \lambda T$ items in the resupply pipeline at all times, where λ is the (daily) demand and T is the resupply time.
- Then [P] would be sufficient spares to avoid downed aircraft.
- So clearly one should aggressively manage supply chain velocity to minimize T, and design component reliability to minimize λ.

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But . . . THE REAL WORLD IS A SPECIAL CASE

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Probabilistic Nature of Component Pipeline

- Suppose a reparable component is managed under *(s-1, s)* resupply. Suppose demands are generated by a Poisson process with mean λ and T is the average resupply time. Then, under certain reasonable conditions, the number of items in the component pipeline is Poisson distributed with mean λT. (Palm's Theorem)
- This can be extended to negative binomial demand distributions, and to non-stationary cases.

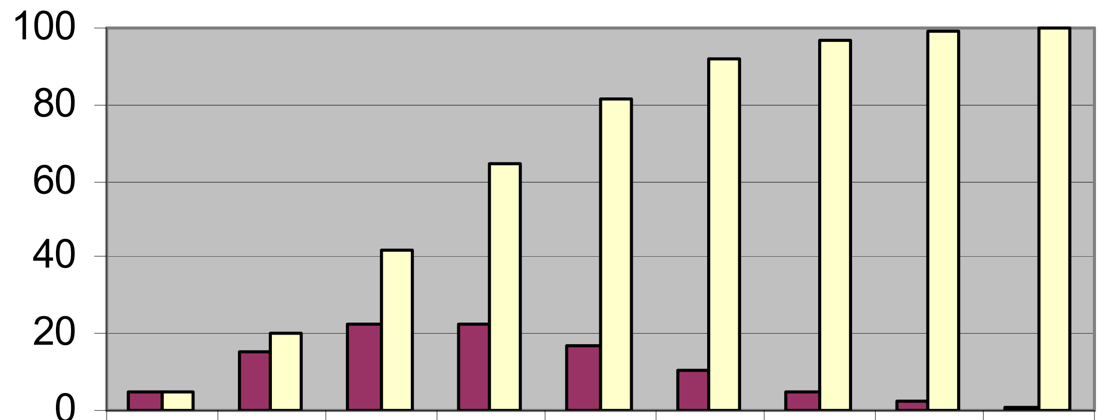
Overview of ASM Method

Demand Process → Pipeline → Backorders → Availability → Item Targets

Demands to Backorders

- Let the item pipeline (units in resupply) equals the daily demand rate times the resupply time
- Let p(n) be the probability of n units in resupply, and suppose there are s spares. Then
- Probability of sufficiency = probability of no backorders $$= \sum_{n=0}^{S} p(n)$$
- Expected backorders = expected unfilled demands $$= \sum_{n=S+1}^{\infty} (n\text{-}s)p(n)$$

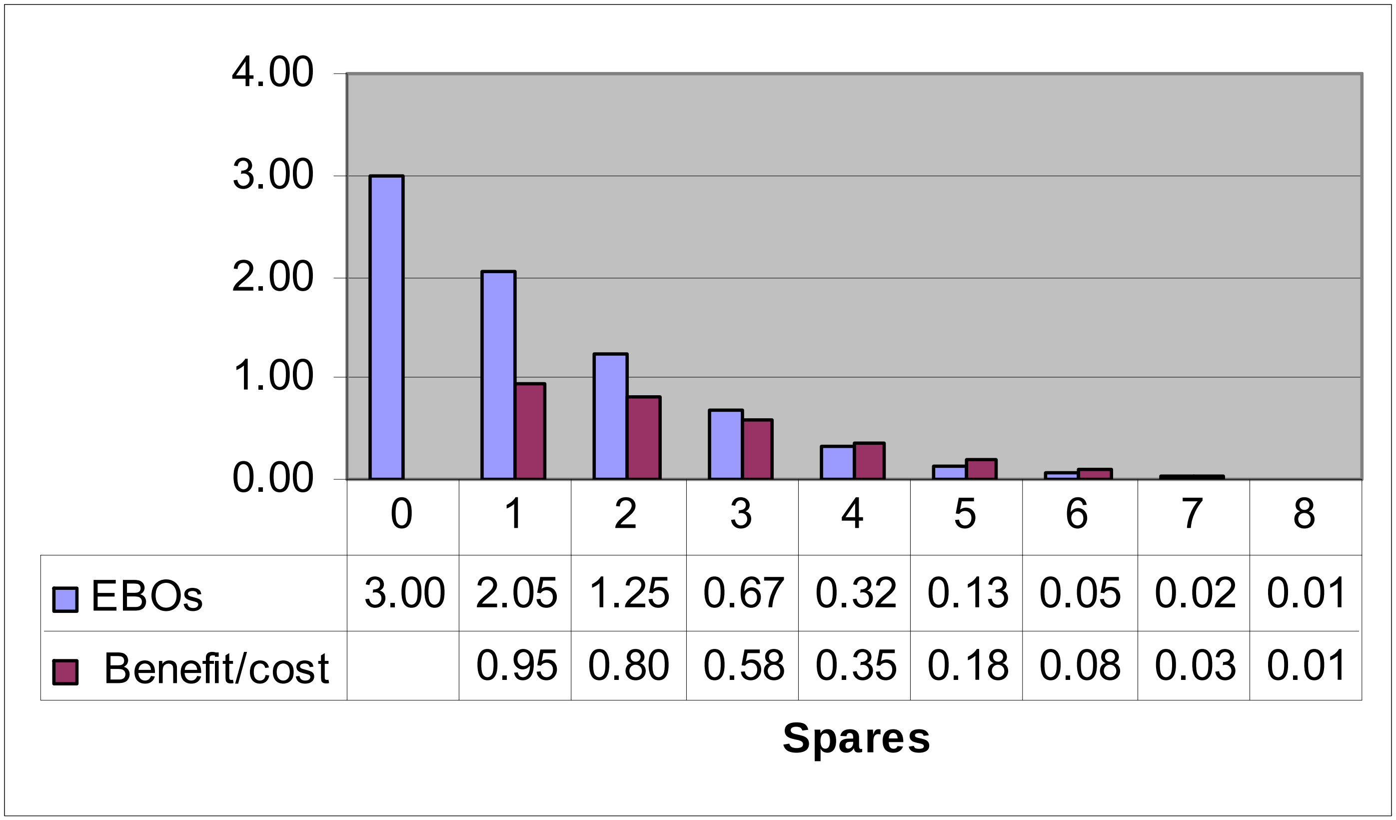
Poisson Probability Distribution (Pipeline Mean = 4)



	0	1	2	3	4	5	6	7	8
PDF(S) %	5	15	22	22	17	10	5	2	1
CDF(S) %	5	20	42	65	82	92	97	99	100

Spares

Item Benefit/Cost Ratio (As spares are added – unit cost $1)



Aircraft Availability

- The probability an aircraft is not down for lack of an item
- In the simplest form, for a fleet of *T* aircraft, with items *i = 1, 2 . . .N* with spares levels *s(i),*

$$AA = \prod_{i=1}^{N} \left(1 - \frac{EBO[i, s(i)]}{T} \right)$$

- Where *EBO [i, s (i)]* is the number of expected backorders for component i with spares level *s(i).*

Marginal Analysis Optimization

- Let f_i, $i= . . .N$, be real-valued functions with domain the non-negative integers. Let C_i, $i=1 . . .N$, be positive real numbers. Suppose that each fi has decreasing differences:

$$\partial_i(s) = f_i(s) - f_i(s-1)$$

$$0 \leq \partial_i(n+1) \leq \partial_i(n)$$

for all n.

- Define sort values

$$V_i(n) = \frac{\partial_i(n)}{C_i}.$$

Marginal Analysis Optimization (continued)

- Form the ordered list of the $v_i(n)$ in descending order. Let LC be any initial section of the list and let C denote the sum of the costs in that section. Let m_i be the largest index for *i* appearing and LC .

- Then the vector (m_i) maximizes $F = \sum f_i$ for cost C.

ASM Model Results

Method	Range	Depth	Cost	Weight	Volume	Total EBO	Total IE
Curr BS	3,227	44,223	$1,025.6K	4,065.8	309.4	158.5K	18.1%
All	7,614	191,379	$773.5K	28,310.8	2,147.8	29.0K	85.0%
Filter 1	6,158	179,366	$707.9K	19,821.4	1,269.0	36.8K	81.0%
Filter 2	6,356	182,145	$757.0K	23,578.2	1,897.1	34.5K	82.2%
Filter 3	5,332	175,980	$746.9K	23,832.2	1,924.0	37.5K	80.5%
XB/XF Sep	8,187	191,563	$3,417.1K	31,138.2	2,630.7	29.0K	85.0%
Final	6,362	99,797	$734.9K	11,103.7	736.2	20.5K	79.5%

- Results for all 3 bases together – 19,258 NSNs
  - Individual base results in backup
- Total EBO is based to EBO for all 19K NSNs, regardless of how many were in the range; rest have a level of 0
- Total IE is based on the Total EBO and is an model estimated value

Results Compared to Actual Deployment

Method	Range used	Range not used	Units Covered	Used Item EBO	Used Item IE	Range used - MICAPs	MICAPs avoided	Units Covered - MICAPs
Curr BS	1,755	1,472	24,631	94.0K	18.1%	509	777	7,562
All	2,455	5,159	52,635	12.3K	89.3%	681	1,166	12,397
Filter 1	2,229	3,929	51,117	13.7K	88.1%	613	1,084	11,327
Filter 2	2,257	4,099	51,370	13.5K	88.3%	622	1,092	11,384
Filter 3	2,143	3,189	50,764	13.7K	88.0%	608	1,089	11,183
XB/XF Sep	2,583	5,604	52,695	12.2K	89.4%	806	1,351	12,606
Final	2,244	4,118	37,327	7.4K	87.2%	655	980	10,952

- Results for all 3 bases together – 19,258 NSNs
  - Individual base results in backup
- Definitions for measures in backup

ASM XF Results

	XF Run Together with XB			XF Run Separately		
Method	**XF Range**	**XF Depth**	**XF Cost**	**XF Range**	**XF Depth**	**XF Cost**
Curr BS	0	0	$0.0K	0	0	$0.0K
All	10	95	$144.9K	721	1,764	$2,793.0K
Filter 2	10	95	$144.9K	132	771	$1,263.5K
Filter 3	10	94	$144.3K	502	1,476	$2,404.7K

- Results for all 3 bases together – 1,021 XF NSNs
- Very little stocked when XF run with XB
- An increase in stocking of 10-20 times when run separately, for an increase in cost of 10-20 times
- Filter 2 removes many XF items due to the “DDR check” portion of that rule
- In all cases, the cost may be too much – look at alternatives

XF Results Compared to Actual Deployment

Method	Range used	Range not used	Units Covered	Used Item EBO	Used Item IE	Range used - MICAPs	MICAPs avoided	Units Covered - MICAPs
All	169	522	388	54	89.2%	140	219	313
Filter 2/60/85%	71	61	151	151	69.6%	65	123	193
Filter 2/30/85%	71	58	84	122	58.6%	65	86	157
Filter 2/15/85%	71	53	67	107	45.2%	65	66	127
Filter 2/15/90%	73	63	79	103	46.9%	67	68	140
Filter 3/60/85%	151	351	273	62	87.5%	129	206	293
Filter 3/30/85%	145	331	173	31	87.5%	124	135	242
Filter 3/15/85%	143	309	133	17	86.8%	122	101	203
Filter 3/15/90%	153	356	162	12	90.6%	130	119	222

- Results for all 3 bases together – 1,021 XF NSNs

XF Summary

- Reducing the length of time of the kit from 60 days to 15 days cuts the cost about in half
  - It has very little impact to the range, range used, and range used for MICAPs
  - It significantly cuts the depth, units covered, MICAP units covered, and MICAPs avoided
- Filter 3 is much more expensive than Filter 2, but saves more backorders

Length of Kit Details

Method	Length	Range	Depth	Cost	Weight	Volume	Total EBO	Total IE
Curr BS	60	3,227	44,223	$1,025.6K	4,065.8	309.4	163.2K	15.7%
Filter 2	15	6,087	56,729	$107.3K	4,279.0	241.8	13.5K	74.7%
Filter 2	30	6,297	100,058	$263.9K	9,866.3	639.6	20.5K	79.5%
Filter 2	45	6,321	141,547	$496.5K	16,579.8	1,273.8	27.5K	81.3%
Filter 2	60	6,356	182,145	$757.0K	23,578.2	1,897.1	34.5K	82.2%
Filter 3	15	5,147	54,164	$106.1K	4,365.8	252.7	17.0K	69.5%
Filter 3	30	5,273	96,096	$261.1K	10,021.4	655.6	23.8K	76.5%
Filter 3	45	5,319	136,468	$491.0K	16,811.2	1,299.4	30.7K	79.1%
Filter 3	60	5,332	175,980	$746.9K	23,832.2	1,924.0	37.5K	80.5%

- Results for all 3 bases together

Length of Kit Details

Method	Range used	Range not used	Units Covered	Range used - MICAPs	Units Covered - MICAPs
Curr BS	1,755	1,472	24,631	509	7,562
Filter 2/15	2,119	3,968	25,600	573	10,269
Filter 2/30	2,192	4,105	37,323	596	10,837
Filter 2/45	2,221	4,100	45,516	612	11,067
Filter 2/60	2,257	4,099	51,370	622	11,384
Filter 3/15	2,010	3,137	24,313	557	10,148
Filter 3/30	2,078	3,195	36,859	583	10,655
Filter 3/45	2,121	3,198	45,023	601	10,826
Filter 3/60	2,143	3,189	50,764	608	11,183

- Results for all 3 bases together – 1,021 XF NSNs

Length Summary

- Reducing from a 60 day kit could save significantly in cost
  - Small impacts to range and actual MICAP coverage
  - Large drop in depth
  - Many more partial units covered versus fully covered
- Reducing the timeframe to no less than 30 days seems like a reasonable trade off of cost and performance